ADAPTATION TECHNOLOGY IN BANGLADESH

GOBESHONA SUB-GROUP ON ADAPTATION TECHNOLOGY

GOBESHONA
Making Research on Climate Change in Bangladesh More Effective

ICCCAD
International Centre for Climate Change and Development

PRACTICAL ACTION
Technology challenging poverty

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This is the first publication of the Gobeshona Sub-group on Adaptation Technology offers an introduction into the country context of Bangladesh with regard to climate change adaptation

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Disclaimer
The contents of this volume do not necessarily reflect the views or policies of contributory organizations. The relevant information in this report has been collected from different government and non-government organizations, published and unpublished documents and through informal communications. The report uses basic data and information up to 2016 to keep harmony among different climate change adaptation technologies and concerns due to unavailability of latest relevant data.

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REPORT - 01

GOBESHONA SUB-GROUP ON ADAPTATION TECHNOLOGY

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MESSAGE

Gobeshona Sub-group on Adaptation Technology is a coalition of organizations and individuals who are active in research and development focusing on climate change. CCDB is happy to lead and host the sub-group. We are thankful to all partner organizations of Gobeshona for giving CCDB the lead. For the last two years CCDB is hosting the theme "adaptation technology" in the annual Gobeshona Conferences.

Climate change has appeared as one of the biggest threats for the civilization. New and improved technologies are therefore important to combat climate change. The sub-group on adaptation technology might play an important role in this regard. Coordinated efforts for knowledge development on adaptation technologies will surely benefit our nation.

I am happy to know that Gobeshona sub-group on Adaptation Technology has prepared this publication with contribution from several organizations and individuals. I would like to thank all the organizations and individuals involved. This is the first publication from the sub-group. I expect that this publication would be a yearly one and would be continued for the years to come. I wish all the successes for the sub-group and also for Gobeshona platform.

Joyanta Adhikari

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MESSAGE

Climate Change is no longer a myth and Bangladesh is one of the countries that have already started experiencing the impacts. At this backdrop, the Adaptation Technology sub-group of Gobeshona took a great initiative to capture and document the fascinating adaption technologies; which already have been in the practiced in communities with success by the different organizations in the country.

Among the adaptation technologies, Practical Action Bangladesh worked focusing people-friendly technology for changing vulnerable people's life and livelihood. When we say technology, we do not mean the smart phone or television that we have; it is beyond that where we translate and transfer the knowledge and skill to the vulnerable people of the country for improving life and creating livelihoods. Few innovations like "Digital Weather Board" saving thousands of people life and assets, "Voice messages with agro-advisory services" helps processing information and translating into adaptable applicable for local context that improving the preparedness of the disaster vulnerable people. Among many innovations of Practical Action, "transforming transitional barren sandbars into productive' is definitely a flagship one to reach the last miles.

Highly appreciate the efforts of Gobeshona for compiling the knowledge and practices for sharing learnings to the wider audiences connecting people across the world. I wish all the successes of the platform-Gobeshona.

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FOREWORD

The Gobeshona consortium is a multi-institutional knowledge management and sharing platform on climate change research in and on Bangladesh. It consists of several dozen universities and research institutions, both government as well as Private and also has established a number of topic specific sub-groups.

One such sub-group is on Adaptation Technology and this report is the first of a series of reports that the sub-group plans to publish over time.

The purpose of this report is to capture and document some interesting adaption technologies that have already been developed and are being put in use in different parts of Bangladesh by different organisations.

As this is the first in a series it has focused on a relatively small number of adaptation technologies in the water and agriculture sectors only.

Future reports will focus on other technologies. We would also like to encourage anyone having developed and tested an adaptation technology who wishes to have it included in a future report to kindly get in touch with us.

We hope that this publication will be useful for those who are looking for sustained technologies to cope with the adverse impacts of climate change. Finally I would like to thank the Gobeshona Adaptation Technology sub-group members both individuals as well as their respective organisations for their hard work in putting together this first publication. Special thanks to CCDB for leading and supporting the publication on Adaptation Technology in Bangladesh.

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1 CONTEXT OF THE REPORT

1.1 Defining Adaptation Technology

Climate change negatively affects human and ecological systems, increases vulnerability and causes a need for adaptation (IPCC 2007, IPCC 2014). In order to achieve adaptation and minimize the extent and adverse impacts of climate change, the promotion of adaptation technology has been internationally recognized as an important strategy in the UNFCCC process (UNFCCC 2010). In its handbook for conducting Technology Needs Assessment for climate change UNFCCC defines adaptation technology as: “the application of technology in order to reduce the vulnerability, or enhance the resilience, of a natural or human system to the impacts of climate change” (UNFCCC 2010). The IPCC Special Report on Methodological and Technological Issues in Technology Transfer made the point that technologies can be deployed to assist in any of the four steps that comprise the process of adaptation to climate change (IPCC, 2000): 1) Information development and awareness raising 2) Planning and design 3) Implementation and 4) Monitoring and evaluation. UNEP, in a report on adaptation gaps clarifies, that adaptation technology is not only a matter of making adjustment or introducing technological equipment. Based on a multidimensional understanding of resilience, vulnerability and adaptation, it also includes organizational and social dimensions (UNEP 2014).

Adaptation technologies have been divided in “hardware” such as capital goods and equipment like drought-resistant crops, early warning systems or sea walls, or “software” such as capacity, knowledge and processes like energy-efficient practices and know-how to operate machinery (UNFCCC 2015). Soft and hard technologies can also be combined, such as an early warning systems that combine hard measuring devices with soft knowledge and skills that can raise awareness and stimulate appropriate action (UNFCCC 2006). Climate change technologies do also cover cross-cutting topics, such as integrating policies, national innovation systems; technology needs assessment and planning, financing and investment, collaboration with the private sector, and intellectual property management (CTCN, 2016).

In order to include this organizational dimension of adaptation technology the categorization of adaptation technology into categorization in software, hardware and orgware has been suggested by Christiansen et al. (2011)(Table 1).

Table - 1. Examples for Hardware, Software and Orgware (Huq and Wright, 2013)

Sector	Hardware	Software	Orgware
Agriculture	Selection of crop or crop variety	Farming practices research on new varieties	Local institutions
Water resources and hydrology	Ponds, wells, reservoirs rainwater harvesting	Increase water use efficiency and recycling	Water user associations water pricing
Infrastructure and settlements including coastal zones	Dykes, seawalls, tidal barriers, breakwaters	Development planning in exposed areas	Building codes, early warning systems, insurance

It is important to point out that adaptation technologies do not necessarily have to be "new" in the sense that they are newly developed. In the contrary: Many technologies that are being used as adaptation technologies such as rainwater harvesting and building houses on stilts do in fact date back and have been used since generations to deal with extreme weather conditions (UNFCCC 2006). Other technologies, however, can be considered as "modern" as their development dates back to the industrial revolution in the late eighteenth century. Examples for this are the introduction of new crop hybrids. "High" technologies are the result of the contemporary level of technological advancement, such as earth observation systems that can provide more accurate weather forecasts, or crops that are based on genetically modified organisms. Finally, there is future technologies which are yet to be invented (ibid)

In most countries and ecosystems, indigenous knowledge of communities has led to responses to different climate-related challenges, which can potentially be replicated and adopted in areas that are likely to be affected by climate change (Huq& Wright, 2013: 4). UNFCCC (2013) found that in their Technical Needs Assessments (TNA's),several Parties prioritized indigenous technologies that could be applied for adaptation, such as traditional designs for housing, bunds, levees, dikes and mangrove plantations. However, Wilk and Wittgren (2009) find that there continues to be a great need to recognize the knowledge held by local people.

1.2 Adaptation Technology under the UNFCCC

At its thirteenth session, the Conference of the Parties reaffirmed the importance of climate change technology (3/CP.13).Following COP 13 in 2007, emphasis on the financing of technology transfer was stepped up, and the Nairobi Work Programme became the focal point for discussions on technologies for adaptation (UNFCCC 2010). Based on the Nairobi Work Programme, the Technology Needs Assessment (TNA) project was established. Implemented by the United Nations Environment Programme (UNEP) and the UNEP DTU partnership on behalf of the Global Environment Facility (GEF), the TNA project assists developing country parties to the UNFCCC with financial, technical and methodological support to determine their technology priorities for the mitigation of greenhouse gas emissions and the adaptation to climate change. The TNA is developed as a country-driven and participatory process that enables developing countries to assess their technology needs and to identify the best technologies to address them based on their development priorities (UNFCCC 2010).In its first phase (2009 – 2013) the TNA supported 36 countries. Since 2014 the project is in its second phase and will facilitate the preparation of TNAs in 26 countries.

In 2010 the Conference of the Parties established the Technology Mechanism to facilitate the enhancement of climate technology development and the transfer to developing countries (UNFCCC 2015). The mechanism consists of two bodies: The Technology Executive Committee (TEC) as the policy arm and the Climate Technology Centre and Network (CTCN) as the implementation arm. The TEC analyses climate technology issues and develops balanced policy recommendations to support countries to achieve the objectives lined out in the Paris Agreement. Key outputs of the TEC are the annual technology-related recommendations to the COP.

CTCN assists countries to realize and implement their objectives as set forth in their Nationally Determined Contributions. CTCN facilitates the transfer of technologies through the provision of technical assistance at the request of developing countries. Hosted by the United Nations Environment Programme (UNEP) in collaboration with the United Nations Industrial Development Organization (UNIDO), CTCN is supported by 11 partner institutions. The Centre fosters collaboration among climate technology stakeholders via its network of national, regional, sectoral and international technology centres, networks, organizations and private sector entities. Three Bangladeshi organizations have become members of CTCN. The International Centre for Climate Change and Development (ICCCAD), Bangladesh Centre for Advanced Studies (BCAS) and KOTHOWAIN (vulnerable peoples development organization) have recently been recognized as network members of the CTCN.

1.3 The Knowledge Gap in Adaptation Technology

Despite progress in the provision of technical support during the UNFCCC process, there is still a technology gap, contributing to the adaptation gap. In an adaptation assessment in 2014 the United Nations Environment Programme diagnosed a wide gap between adaptation needs and reality (UNEP 2014). The report furthermore identified a finance, technology and knowledge gap contributing to the adaptation gap (ibid.).

Knowledge gaps have been repeatedly cited as important adaptation constraints by practitioners and stakeholders (Klein et al. 2014, cited in UNEP 2014). According to the report by UNEP (2014) the knowledge gap exists at different levels: (i) missing or incomplete knowledge (gaps in knowledge production); (ii) inadequate linkages between different bodies of knowledge (gaps in knowledge integration); and (iii) limited diffusion and translation of knowledge to decision-makers (gaps in knowledge transfer and uptake).

Crucially, the knowledge gap directly affects the technology gap. A lack of knowledge about appropriate adaptation technologies and their correct application causes even available adaptation technologies not to be used or used in an ineffective manner. The UNEP report concludes that “Although there is a clear need for producing new knowledge in certain areas, a considerable body of knowledge on adaptation already exists and could be used more effectively. Integrating such knowledge from different sources and making it available to decision-makers at different levels is arguably the most important knowledge need” (UNEP, 2014: 65).

Asian Development Bank (ADB), in a report on technologies to support adaptation to climate change in developing Asia, finds that there is a lack of consistent, comprehensive information about the most recent developments in adaptation technologies and a lack of access to institutions and agencies that can facilitate technical and knowledge transfer (Asia Development Bank, 2014:1). Consequentially, adaptation practitioners are held back from developing a robust portfolio of hard and soft adaptation technologies (ibid.).

1.4 Purpose of the Report

The Gobeshona Adaptation Technology Sub-Group was formed during the 2nd Annual Gobeshona Conference held in 8-11 January in 2016 led by Christian Commission for Development in Bangladesh (CCDB) to develop a knowledge hub on the adaptation technologies that are practiced in the key sectors of the country. The sub-group brings together a group of relevant institutions and individuals, thereby accumulating and exchanging knowledge on adaptation technologies that are developed or implemented by different organizations. In this report the Gobeshona Adaptation Technology Sub-Group seeks to address the dimension of the knowledge gap regarding adaptation technologies by diffusing the experiences with adaptation technologies used in Bangladesh.

Gobeshona is a knowledge sharing platform for climate change research in Bangladesh. By bringing together the national and international research community, Gobeshona creates a mechanism to enhance the quality and effectiveness of research made in Bangladesh. At the same time, Gobeshona contributes to the international discourse on climate change adaptation technologies by sharing the pioneering and first hand experiences made in Bangladesh as a country which is both particularly vulnerable to climate change and pioneering in the area of adaptation.

Since Bangladesh is regarded as adaptation capital (Irfanullah, 2013), different adaptation practices has been developed and introduced by different actors. This report is an attempt to portrait scenario of adaptation technologies related to agriculture and water sectors. However, being the first report of the sub-group the report is also indented to provide overview of national and international processes related to adaptation technologies. This is also to provide information on the sub-group and how it does work.

1.5 Objective of the Gobeshona Sub-group on Adaptation Technology:

The overall objective of the knowledge based platform is to enhance capacity through cooperation and to serve as a center of excellence on issues related to adaptation technologies in different sectors. Specific objectives are to:

- Act as research hub and initiating research to enhance knowledge on the best adaptive practices in different sectors.
- Exchange knowledge and experience on the relevant issues among the members and making them accessible nationally and internationally.
- Provide concrete technological solutions to enhance adaptive capacity at both community and national levels.
- Build a network and partnership with relevant stakeholders at regional and international levels.

1.6 Activities of the Sub-group

In order to meet the desired objectives, the sub-group decided to focus on a number of activities which include but are not limited to:

- Collecting and reviewing of adaptation technologies to prepare a national database.
- Organizing of seminars on adaptation technology.
- Organizing of fieldtrips to climate vulnerable areas.
- Networking and establishing linkage with government and non-government research organizations and universities.
- Producing reports and dissemination of findings among stakeholders.

1.7 Working Approach

The sub-group is headed by Christian Commission for Development in Bangladesh (CCDB). Meetings to decide about next steps are held on a monthly base and hosted by the members in rotation. Proactive cooperation and participation are the leading principles of the sub-group. Decisions are made in a participatory manner.

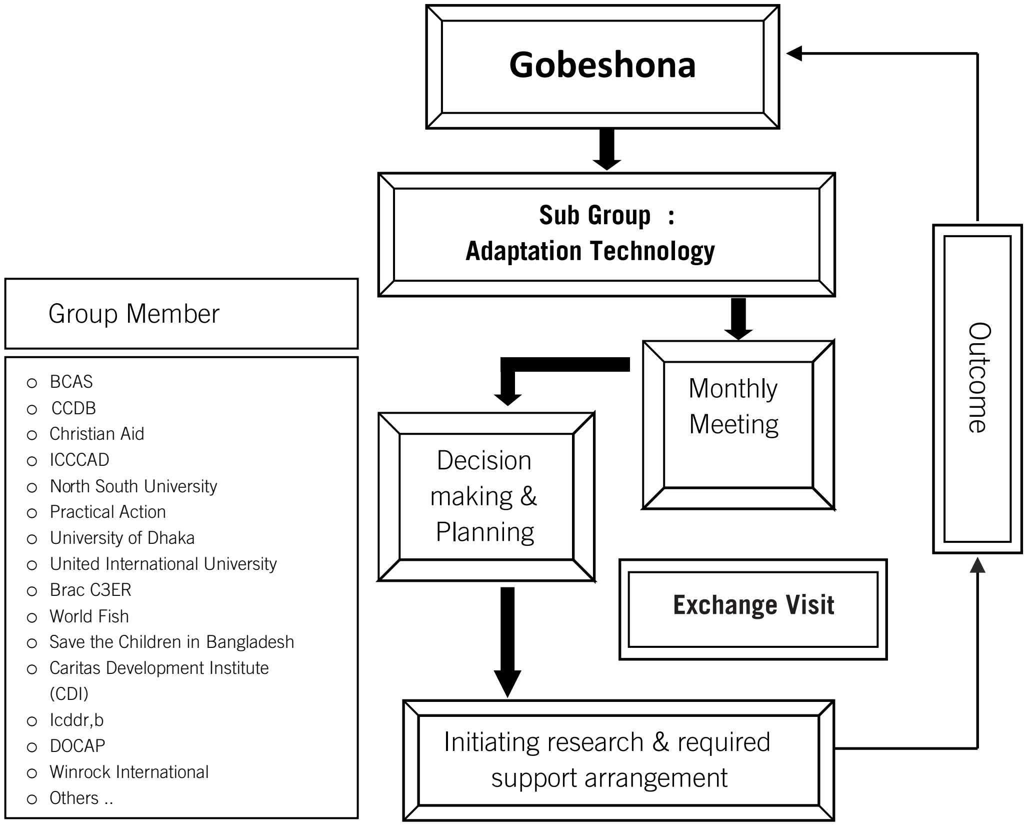


Figure 1: Framework of the Gobeshona sub-group on Adaptation Technology

Rainwater Harvesting Plant, Patharghata, Barguna

2 BANGLADESH COUNTRY CONTEXT

2.1 Climate Change in Bangladesh

Bangladesh has been repeatedly listed as the most vulnerable country to climate change (Maplecroft 2013, Maplecroft 2014, Maplecroft 2015). Bangladesh is highly vulnerable to climate change impacts (Huq and Rabbani, 2011; Sarker et al., 2012). According to the IPCC`s Fifth Assessment Report (AR5) (IPCC 2013) Bangladesh is at special risk from climate change due to its exposure to sea-level rise and extreme events and the concentrated multidimensional poverty in the country. Asia Foundation (2012:18) finds that the combination of high population density, low income, weak infrastructure, and its location on a low-lying delta makes Bangladesh especially subject to frequent natural disasters and especially vulnerable to impacts of climate change.

There will be significant and continuing climate change impact in Bangladesh (AR5) (IPCC 2013). In Asia, the rise of temperatures is expected to continue with both seasonal and regional variations. All over the continent, changes in precipitation patterns, including extremes, are expected with variation in frequency and intensity. Increase in precipitation are projected to be the largest in North and East Asia. In Bangladesh annual mean rainfall has already increased and extreme weather events have become more frequent and intense. It is possible that extreme weather events such as heat waves and intense precipitation could become more commonplace in South, East, and Southeast Asia (Asian Development Bank 2014). Bangladesh is subject to intensified climatic stresses such as more extreme hot and cold spells; rainfall being less when it is most needed for agriculture, yet more in the monsoon when it already causes floods; faster melting of glaciers in the source areas of Bangladesh's rivers altering the hydrological cycle; more powerful tornadoes and cyclones; and sea level rise (Asia Foundation 2012).

Impacts of climate change are exacerbating many of the current problems the country faces and will challenge the country's ability to achieve continuous higher economic growth to eradicate poverty at an expected pace (Ministry of Environment and Forest 2012).

World Bank (2016) estimates, that with a per capita gross domestic product (GDP) of about $1,220, the economic losses in Bangladesh over the past 40 years were already at an estimated $12 billion, depressing GDP annually by 0.5 to 1 percent. Floods, droughts, loss of land and saltwater intrusion harm the agriculture-based economy in Bangladesh, threatening the livelihoods of millions of people (ibid.). IPCC finds, that in a low crop productivity scenario, Bangladesh would experience a net increase in poverty of 15% by 2030 (IPCC 2013).

Bangladesh's population at risk of sea level rise is predicted to grow to 27 million by 2050 (Wheeler, 2011; Chapter 13, IPCC 2013). Two-thirds of Bangladesh are less than five meters above sea level, and floods increasingly inundate homes, destroy farm production, close businesses, and shut down public infrastructure. According to the World Bank (2016) erosion leads to an annual loss of about 10,000 hectares of land and weakens natural coastal defenses and aquatic ecosystems.

Bangladesh is rated as being high-risk to multiple devastating climate events (Maplecroft 2013b). Bangladesh and India account for 86% of mortality from tropical cyclones, mainly due to having the rarest and most severe storm categories. The vulnerability to cyclones is also expected to increase (Box 16-2; Chapter 16, IPCC 2013). Floods have led to complex humanitarian disasters (Nizamuddin, 2001).

The effects of climate change on water, agriculture and infrastructure lead to increased migration to the cities that are already at the limit of their infrastructural and social capacity. In response to the water related threats, migration to urban areas is increasing as people search for new economic opportunities. However, they often end up in urban slums and will be among those most affected by climate change. Urban slums in Bangladesh are already overcrowded, poorly managed by municipal governments, and face severe constraints in providing water and sanitation services (Asia Foundation 2012: 19).BCCSAP (GoB 2009) estimates that the combination of sea level rise, an increase in saline intrusion of freshwater sources, and an increase in cyclone and storm surges in the near future, threatens to displace more than 20 million people.

2.2 National Policies on Adaptation Technology in Bangladesh

Bangladesh is recognized internationally for its cutting-edge achievements in addressing climate change and has been described as 'adaptation capital of the world' (Irfanullah, 2013).

The country benefits from a very active sector of non-governmental and community-based organizations (NGO`s, CBO`s) who are implementing a number of projects addressing climate change in Bangladesh (Asia Foundation 2012). The government of Bangladesh has recognized that climate change poses a serious threat to Bangladesh's goal to accelerate economic growth, substantially eradicate poverty and become a middle-income country by 2021 (Planning Commission GoB 2010). Taking steps to address climate change, Bangladesh prepared national policies and strategies to achieve climate-resilient development.

Bangladesh is the first developing country which produced a National Adaptation Programme of Action (NAPA) (MoEF 2005). In 2009 the country developed Bangladesh Climate Change Strategy and Action Plan (BCCSAP), a national strategy to address climate change. Unlike the NAPA the BCCSAP was not developed to meet a national commitment to the United Nations Framework Convention on Climate Change (UNFCCC) but rather a nation-driven initiative, prepared as a part of the country's overall development strategy (Irfanullah, 2016). BCCSAP builds on the lessons learnt from the NAPA process and was prepared through a participatory approach. BCCSAP explicitly aims at enhancing adaptive capacity of vulnerable communities (Planning Commission GoB 2009).

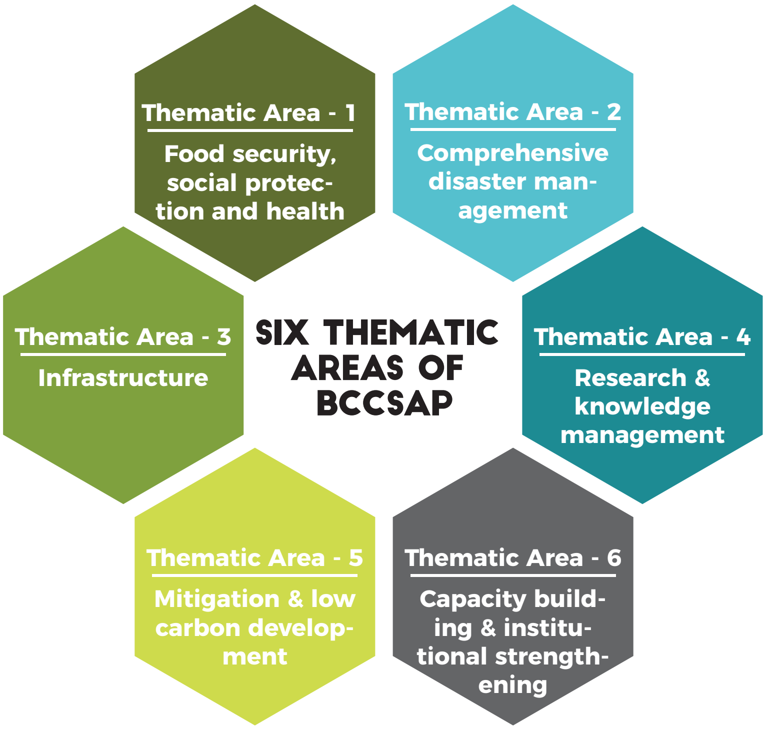


Figure - 2. Thematic Areas of BCCSAP 2009

The strategic plan introduces 44 programmes in 6 areas. These areas are: food security, social protection and health; comprehensive disaster management; infrastructure; research and knowledge management; mitigation and low carbon development; and capacity building and institutional strengthening. BCCSAP specifically addresses technology and points out the need for `innovative adaptive measures through introduction of new and appropriate technologies in order to achieve climate resilient development. It the Sixth Five-Year-Plan 2011-2015 (Planning Commission GoB 2011) GoB recommends to tackle climate change vulnerability through programmes in agriculture, water, environment and disaster management and names environmental sustainability as one of the six core targets of the Sixth FYP. The Seventh five year plan acknowledged technology as one of the major issues (Planning Commission GoB 2015a). Furthermore, Bangladesh developed in 2015 a Roadmap for developing a National Adaptation Plan (NAP) and the country is currently in the process of developing the NAP. In 2018 also the BCCSAP is due for an update.

In order to access climate change finance and ensure effective implementation, the Bangladesh Climate Change Trust Fund (BCCTF) was established, legally supported by the Bangladesh Climate Change Trust Act 2010. Funding is also provided by the Bangladesh Climate Change Resilience Fund (BCCRF), which was created by international development partners and is managed by the World Bank. Bangladesh has already invested more than $10 billion in climate change actions. These included enhancing the capacity of communities to increase their resilience, increasing the capacity of government agencies to respond to emergencies, strengthening river embankments and coastal polders (low-lying tracts of lands vulnerable to flooding), building cyclone shelters and resilient homes, adapting rural households' farming systems, reducing saline water intrusion, especially in areas dependent upon agriculture, and implementing early warning and emergency management systems (World Bank 2016).

In 2012 the Ministry of Environment and Forests (MoEF) took further steps and prepared a comprehensive technology needs assessment and technology action plans for climate change adaptation (MoEF 2012). The assessment links to the BCCSAP and identifies the water and the agriculture sector as priorities in the context of national development goals, naming a number of technologies for each sector to be prioritized. Following the lead of the BCCSAP the following overview on adaptation technologies in Bangladesh will focus on these two sectors.

3 ADAPTATION TECHNOLOGIES IN THE AGRICULTURE SECTOR

3.1 Effects of Climate Change on the Agriculture Sector in Bangladesh

The economic strength of Bangladesh still depends largely on the agriculture sector. Approximately 1.2 million hectares of land in Bangladesh is used for agricultural production. The sector is extremely vulnerable to higher temperatures and changing rainfall patterns. Increased flooding and drought, and rising salinity in coastal areas affect crop yields and crop production (Asia Foundation, 2012:18). The Intergovernmental Panel on Climate Change (IPCC 2013) estimates that by 2050 rice production in Bangladesh could decline by 8 percent and wheat by 32 percent (against a base year of 1990), which could lead to serious food insecurity. In a low crop productivity scenario, Bangladesh would experience a net increase in poverty of 15% by 2030 (IPCC 2013).

The livelihood of the vast majority of the population in Bangladesh is based on the agricultural sector, it serves as the largest employer by far as 47.5% of the population is employed directly and around 70% of the population depends on this sector in one form or another for their livelihood (Planning Commission GoB 2015). Agriculture plays a fundamental role in reducing poverty as well as promoting nutritional diets especially in the country side where the production and consumption patterns are closely linked.

Asian Development Bank (2014) finds that in South Asia wheat-growing areas could shrink by half as higher concentrations of carbon dioxide (CO_2) cause heat stress. Rising sea levels will pose an increasing threat to rice production in low-lying areas, including the Lower Mekong Basin. Uneven growth in vegetation due to erratic seed dispersal and higher sea surface temperatures will seriously affect terrestrial and marine ecosystems, making it harder for animals to find suitable feeding and breeding habitats. Stress will be placed as a result on the economic, food, and livelihood security of the millions of people living in the coastal regions of Asia.


Floating Vegetable Bed, Mitradanga, Tungipara, Gopalganj

In its latest assessment report, the IPCC finds that in Bangladesh terms of risks of increasing heat stress, current temperatures are already approaching critical levels during the susceptible stages of the rice plant in Bangladesh in March-June (IPCC 2014: viii). During the drier months (October to May) however, lack of rainfall causes droughts that lower crop yields, increase food stress and scarcity, and lead to higher food prices overall (Asia Foundation 2012). In the Indo-Gangetic Plains of South Asia, there could be a decrease of about 50% in the most favorable and high yielding wheat area due to heat stress if CO_2 levels are doubled (IPCC 2014: vii).

Seawater inundation and resulting high salinity in soil and water has become a major problem for traditional agriculture (IPCC 2014: ix), particularly during dry months. Salt water intrusion due to sea-level rise in low-lying plains of the country. High salinity harms agriculture and has intensified the risk of food insecurity, the disappearance of employment opportunities for agricultural workers (World Bank 2016). The impact of climate change on agriculture is already evident in eco-sensitive zones like coastal, drought and flood prone areas of the country (Hoque and Haque 2016).

TEC Brief #4 on adaptation technology in the agriculture sector the Technology Executive Committee (TEC) of the UNFCCC has identified following technologies as most relevant as adaptation in the agriculture sector (TEC 2014): seasonal forecasts, water-saving irrigation, resilient crop-varieties and farmer-led sustainable agriculture. These encounter specifies enablers and barriers (Table 2).

Table - 2. Enablers, barriers and examples of adaptation technologies for agriculture (TEC 2014:8)

Adaptation Technology	Seasonal Forecasts	Water Saving Irrigation	Resilient Crop Varieties	Farmer-led Sustainable Agriculture
Suitability of the Technology	For Supporting Agricultural and relevant planning decisions and early warning for preparedness	For tracking farmer vulnerability to the effects of drought and variable rainfall Patterns.	For enhancing crop resistance to a variety stresses such as water and heat stress, salinity and new pests; for food security	For ensuring farmer ownership and sustainability of agricultural techniques in context.
Enablers	Effective stakeholder collaboration; access to information and comprehensive communication approaches that engage all stakeholders and target audience	Context-aware planning, management and governance; multi stakeholder collaboration; application in areas that rely on rain fed agriculture; accessible and ongoing troubleshooting support	Institutional engagement in policy dialogue to speed up process and access; in –situ testing with flexible, bottom-up cropping methods; affordability for intended users	Comprehensive farmer engagement; use of locally available resources; local applicability; policy support to encourage diffusion; CBA to ensure ownership of technologies.
Barriers	Communication barriers including channels used. Language and Literacy issues; understanding and awareness of Technology	Availability of water resources; soil type; top down site governance and management; opportunity costs & cost effectiveness of irrigation; perceptions of resource use by final stakeholders	Perceptions of and access to markets and new varieties; expense of resistant varieties	Comprehensive farmer engagement; use of locally available resources; local applicability; policy support to encourage diffusion; CBA to ensure ownership of technologies.
Examples	ClimAfrica Project brings together 18 institutions to improve understanding of Climate Change and impacts in Africa: www.climafrica.net	Kenya Rainwater Association use e water saving drip irrigation in a number of rainwater harvesting and management projects; www.gharainwater.org/kenya-projects	The international Rice Research Institute develop rice varieties to withstand changing. www.irri.org/our-work/research/better-rice-varieties/climate-change-ready-rice	Practical Action have developed and replicated floating gardens with farmers in Bangladesh; www.practicalaction.org/climatechange_floatinggardens

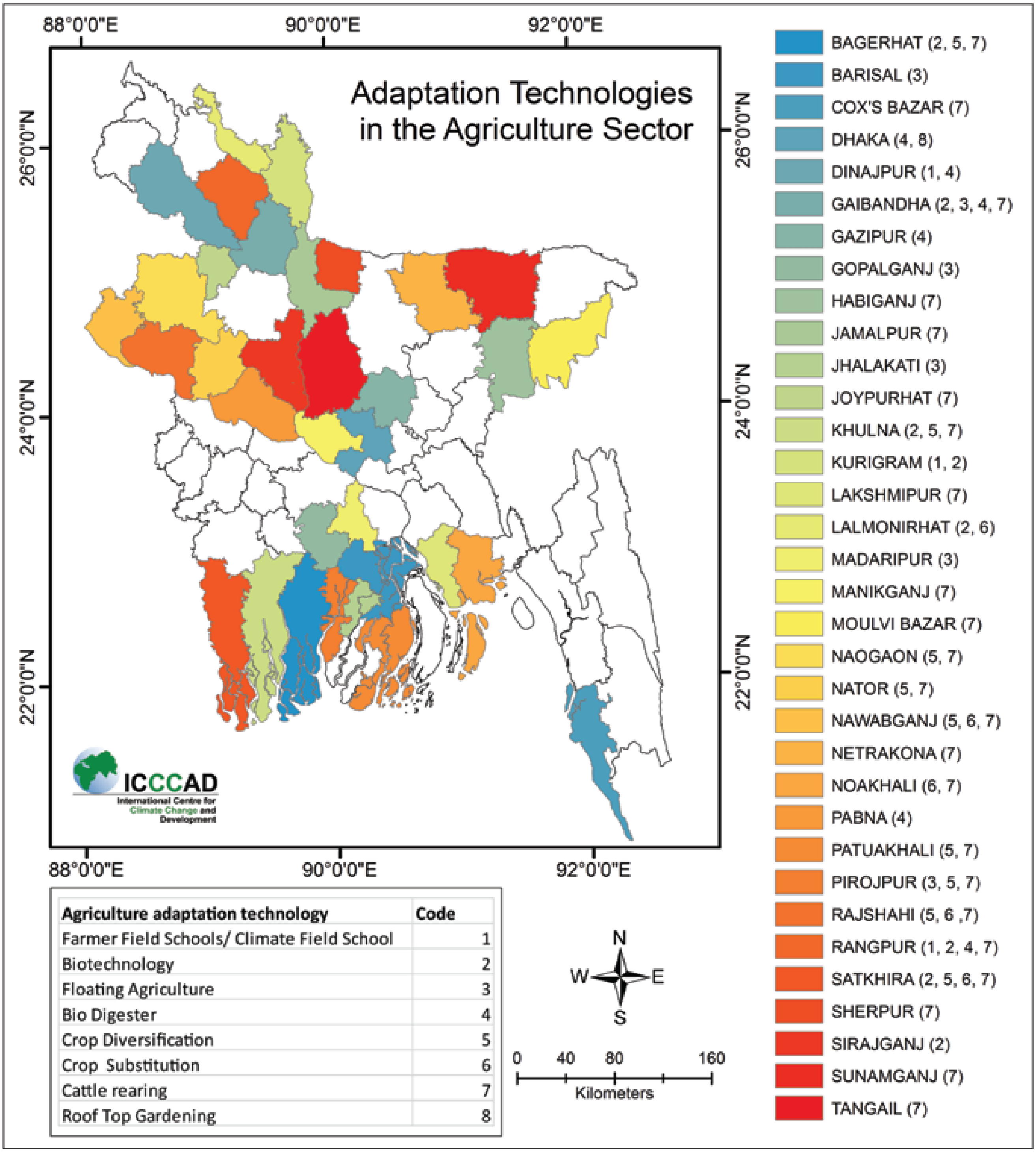
Bangladesh has been responding to the climate challenges and as well as trying to be prepared to face the future ones. Technology plays a very crucial role in triggering the capacity to face existing and upcoming challenges. In its Technology Needs Assessment (TNA) (GoB 2012) the GoB identified and prioritized the following technology options for the agriculture sector:

- Development of salinity-tolerant rice varieties;
- Development of drought-tolerant rice varieties;
- Development of short-maturing rice varieties;
- Training on improved farming practices for crops, irrigation and water management, soil fertility management (conservation and restoration of soil quality) etc;
- Establishment of climate-smart Agriculture Technology Dissemination Center;
- Establishment of special agricultural Research & Development Centre; .
- Land-use planning

3.2 Overview on Adaptation Technologies in the Agriculture Sector in Bangladesh

Most adaptation technologies in the agriculture sector can be found in the coastal areas of Bangladesh as well as in the North West of the country.

The technology most used is Crop Diversification in nine districts, followed by Biotechnology in eight districts and Crop Substitution in seven districts. Floating Gardens and Bio Digester have been found in six districts. The technologies less wide spread are Farmer Field schools in three districts and Rooftop Gardening, which has only been found in one district (Figure 2).A more detailed version of the adaptation technologies in the agriculture sector can be found in Annex- 6.



Agriculture adaptation technology	Code
Farmer Field Schools/ Climate Field School	1
Biotechnology	2
Floating Agriculture	3
Bio Digester	4
Crop Diversification	5
Crop Substitution	6
Cattle rearing	7
Roof Top Gardening	8

Figure - 3. Adaptation technologies in agricultural sector based on Annex-6

Dry Seed Bed for Boro Rice, Shibalaya, Manikganj

3.2 Case Studies on Adaptation Technology in the Agriculture Sector in Bangladesh

3.2.1 Participatory Research and Ownership with Technology Information and Change (PROTIC) by Oxfam in Bangladesh

Providing meteorological information to women in marginalized rural communities with Information and Communication Technology (ICT).

Project name and organization:	Participatory Research and Ownership with technology, Information and Change (PROTIC), Oxfam
Technology Description:	200 female farmers from the two areas (100 from each area) have been equipped with smart mobile phone along with internet scheme. Through these mobile phones they receive SMS, Outbound Dial (OBD), Interactive Voice Response (IVR) Apps and Call Centre services on agriculture agro meteorology, and an early warning system.
Type of Technology:	Soft
Replicable for:	Water, Agriculture, Disaster management
Addressed Problem:	Knowledge Gap
Description:	Use of modern information communication technology to make relevant information accessible to marginalized communities

*Detail case studies can be found in Annex - 4


Female Farmer, Borokupot Village, Atulia, Shyamnagar

Key learnings:

- The use of Information and Communication Technology (ICT) is a viable approach to ensure and improve agricultural production under climate stress and to create economic resilience;
- The ICT trainings empowered participants beyond agriculture as the skills are transferable;
- The cross-cutting collaboration with private sector, universities and local NGO partners contributed to the success of the project;
- The Participatory Action Research approach and the close involvement of the community during the project ensured that the technologies were used.

3.2.2 Pumpkins against Poverty by Practical Action Bangladesh

Project name and organization:	▪ Pumpkins against Poverty (UKaid) ▪ Securing Water for Food (USAID, the Govt. of NL, SIDA and Science and Technology, South Africa) by Practical Action Bangladesh.
Type of Technology:	Hard
Replicable for:	Other areas with sandbars.
Addressed Problem:	Food insecurity, river erosion induced livelihood stress, extreme poverty
Description:	Using Sandbar Cropping technology barren sandy land can be made productive to compensate the loss of land due to riverbank erosion.

*Detail case studies can be found in Annex-4

Sandbar Cropping, Rangpur

Technology Description: After each rainy season, substantial sandy islands (transitional sandbars) show up in the fundamental streams of the Teesta and Bhramaputra rivers. These islands are the common property as barren resources, and are not utilised for any gainful or productive purposes. The sandbar cropping technology effectively exhibited that growing pumpkins in small compost-pits is both possible and productive. In the sandy island, pits comprising a size of $1m^3$ are dug. Then compost is inserted inside the pit and then the seeds are sown. After that, regular nurturing and irrigation is done by the farmers until the final harvest comes. Other than the pumpkin, some other crops like squash, cabbage, lettuce, parsley, capsicum, strawberry, melon, onion, flowers like marigold, gladiolus, dalia is being harvested on trial basis. Among these crops, squash is being harvested alongside pumpkins on commercial basis.

Key Learning:

- Demonstrated the effectiveness of sandbar cropping technique to use the usually barren sandbars for a productive purpose, improving food security, family nutrition and productivity at the household and national level by increasing income and asset generation;
- Women can easily uptake the technique and also actively participate;
- Combining sandbar cropping with a livestock approach and the facilitation of access to markets can provide income security across seasons and avoid fertilizer costs;
- Making barren land fertile can compensate for land loss due to climate change;
- The technology is not climate proof and as such farmers will need weather forecast.

Artificial Aquifer, Sangsoil, Niyamatpur, Naogaon

4 ADAPTATION TECHNOLOGIES IN THE WATER SECTOR

4.1 Effects of Climate Change on the Water Sector in Bangladesh

Different physical effects of climate change include increased temperature and precipitation, increased salinity and extreme weather events such as floods, cyclones and droughts have profound negative impacts on Bangladesh's water resources (Shahid and Behrawan, 2008). The variability of weather patterns can lead to flooding and drought as direct results and indirect impacts such as reduced availability and quality of freshwater. In the northern part of Bangladesh floods in the monsoon season and drought in the dry season – and other associated stressors like upstream river diversion and damming, can have severe implications for water resources and agricultural yields (Kolås et al., 2013).

Strong storm surges from cyclones often batter coastal areas, causing significant loss of lives and damage to property and livelihoods. Extreme high tides erode coastal lands and embankments. Flooding, erosion, and saline intrusion all threaten Bangladesh's water infrastructure, which has frequently been breached during storms, cyclones, and floods that have led to complex humanitarian disasters (Nizamuddin, 2001). Coastal aquatic ecosystems have been severely compromised (World Bank 2016).

The aggravating crisis of fresh water due to climate change and its associated impacts is already visible in many parts of Bangladesh and the scenario is expected to worsen in the near future (Ahmed et al., 2015). Fresh water has become scarcer in Bangladesh's drought-prone northwest and in southwest coastal areas, where about 2.5 million poor residents do regularly suffer from shortages of water for drinking and irrigation (World Bank 2016).

It has been projected that in the coastal areas there will be a 7% increase in brackish water areas in 2050 compared to that of 2005 which may expose an additional 7.6 million people to high salinity (>5 ppt) (WHO, 2015). Lack of freshwater aquifers at suitable depths and high salinity in the surface water (NGOF, 2015) has forced the coastal community to depend mainly on rainwater harvesting, fresh water pond, deep tubewell, pond sand filters (PSF) and pond/canal water for drinking and irrigation purposes. Additionally, a shortage of safe drinking water is likely to become more acute, especially in the southern coastal areas and drought-prone areas in the northwest (Asia Foundation 2012: 19)

IPCC (2007) acknowledged the importance of expanded rainwater harvesting, water storage and conservation techniques, water re-use; desalination, efficiency in water use, and effectiveness in irrigation as climate change adaptation technologies in the water sector.
TEC Brief #5 on adaptation technology in the water sector the Technology Executive Committee (TEC) of the UNFCCC has identified following technologies as most relevant as adaptation in the water sector (TEC 2014): boreholes and tube wells, rainwater harvesting, desalination and water management fora. These encounter specific enablers and barriers (Table 3).

Managed Aquifer Recharge, Gangarampur, Batiaghata, Khulna

Table - 3. Enablers, barriers and examples of water adaptation technologies (Technology Executive committee 2014a:8)

Adaptation Technology	Boreholes and tube wells	Rainwater Harvesting	Desalination	Water management fora
Suitability of the Technology	For extracting water from subsurface and groundwater levels to provide access to safe drinking water and enhance water efficiency	For collecting rainwater from rooftops and other catchments to supplement domestic and Institutional water supply and increase water efficiency	For purifying saline water through the removal of sodium chloride and other dissolved constituents	For bringing multiple stakeholders together, to discuss options and develop comprehensive plans
Enablers	Cost and time efficiency; institutional support; reuse of resources through rehabilitation	User land/ property tenure; links to climate forecasts; storage options	Appropriate planning; political and financial support; comprehensive environmental assessments	Cost efficiency; training provision; Institutional and individual enthusiasm for collaboration
Barriers	Inappropriate governance approach; differentiated stakeholder access; lack of geological assessment; inadequate energy supplies; Technical barriers	Lack of rainwater; lack of initial Investment capital; lack of technical knowledge and resources	Cost and energy requirements; negative ecosystem effects; lack of disposal options for removed minerals; political opposition	Diverse objectives of stakeholders; governance needs; poverty; cultural traditions; lack of Technical and financial resources to access identified needs
Examples	UNICEF's rehabilitation and reparation of boreholes in Somalia. www.unicef.org	World Agroforestry Centre's rainwater harvesting projects in Africa: www.worldagroforestrycentre.org	Reverse Osmosis Desalination plant in Egypt: http://www.pureaqua.com/reverse-osmosis-water-treatment-in-egypt/	GIZ-JOHUD' 'Water Wise Women' initiative in Jordan: https://www.giz.de/en/worldwide/27387.html

In its Technology Needs Assessment (TNA) (GoB 2012) the government of Bangladesh has identified the following technological measures that are required to make the water sector and its subsectors resilient to the impacts of climate change:

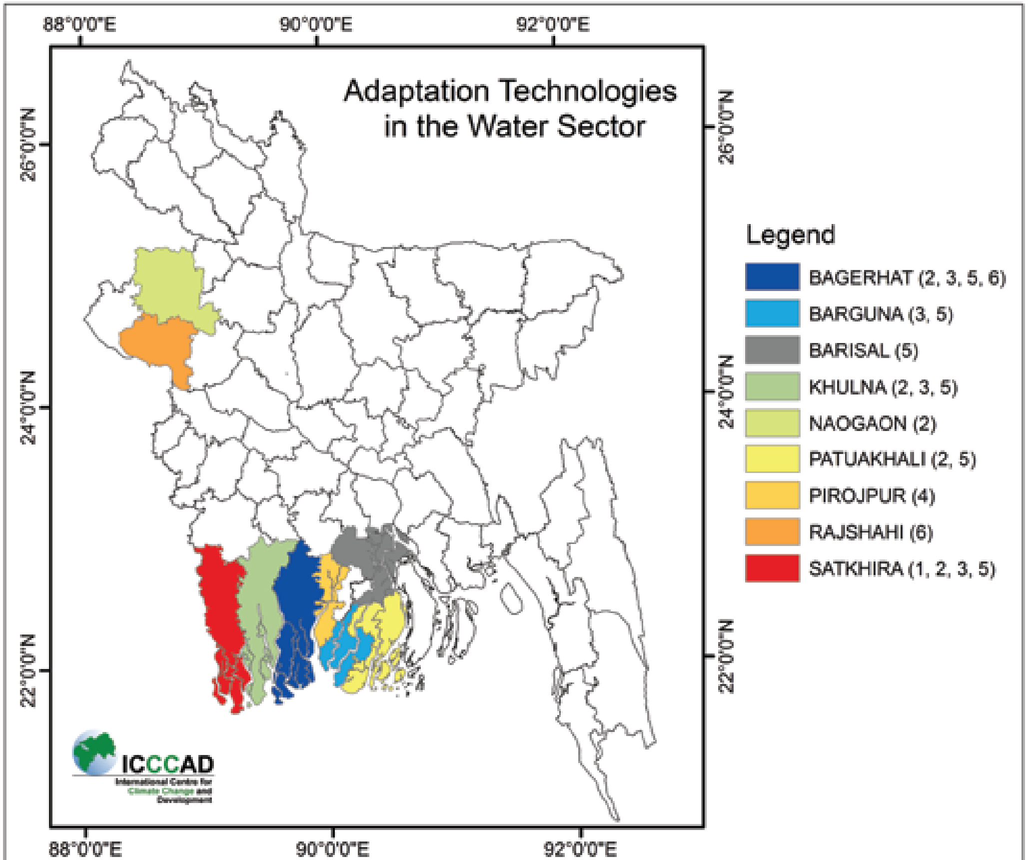
- Rehabilitation of existing embankments/ dykes and dredging;
- Tidal barriers (sluice gates);
- Tidal river management including computer simulation of tidal flow;
- Comprehensive disaster management incorporating early warning systems and involving community;
- Monitoring of sea level rise, tidal fluctuation, salinity intrusion, sedimentation and coastal erosion; and
- Urban Infrastructure development.

4.2 Overview on Adaptation Technologies in the Water Sector in Bangladesh

The Government of Bangladesh and many non-government actors have initiated programmes and projects related to technologies to enhance access to freshwater while communities have also adopted (over time) or adapted (in changing climate) various technologies and/or interventions to meet their freshwater needs. Some potential technologies such as Managed Aquifer Recharge (MAR) and Artificial Aquifer Wells are also in operation in some parts of Bangladesh.

Access to freshwater in the coastal zone is limited and an impact of climate change is only likely to exacerbate the situation. Several adaptation technologies in the water sector can be found in the coastal areas of Bangladesh. The scoping research found technologies in the districts Satkhira, Khulna, Bagerhat, Pirojpur, Barguna, Barisal and Patuakhali. Technologies used in these areas include Desalination, Rainwater Harvesting, Pond Sand Filter, Artificial Aquifer Tube Well and Deep Tubewell. Other areas for water technologies can be found in the North West of the country in the districts of Naogaon and Rajshahi with technologies of Solar Disinfection and Rainwater Harvesting (Figure 3).

The technology most used is the deep tube well, which has been found in six districts. The second most used technology is Rainwater Harvesting, which has been found in five districts. After this follows the Pond Sand Filter found in four district sand Solar Disinfection, that has been found in two districts. The least wide spread technologies are the Artificial Aquifer Tube Well and Desalination, which each have been found only in one district.In general, there has been less technology found in the water sector compared with the agriculture sector.



Water adaptaton technology	Code
Desalination	1
Rainwater Harvesting	2
Pond Sand Filter	3
Artificial Aquifer Tube Well	4
Deep Tubewell	5
Solar Disinfection	6

Figure - 4. Adaptation technologies in water sector based on Annex-7

Pond Sand Filter (PSF), Pachbaria, Kaliganj, Shatkhira

4.3 Case Studies on Adaptation Technology in the Water Sector in Bangladesh

4.3.1 Pond Sand Filter (PSF)

Project name and organization:	Ensuring Food Security and Saline Resilient Livelihood through Community Based Adaptation, Satkhira Unnayan Sangstha (SUS)
Technology description:	technology is built around artificially constructed ponds which are replenished by rainwater during the monsoon season. The rainwater collected in these ponds is pumped by hand into a storage tank through a filter chamber where it gets cleaned.
Type of Technology:	hard
Applicable in:	areas where there is adequate (seasonal) Rainfall.
Addressed Problem:	lack of clean water and resulting health issues
Description:	Enabling access to clean drinking water to improve the health of community

Key learning:

- The Pond Sand Filter provides a viable solution to scarcity of drinking water in areas of Bangladesh with adequate seasonal rainfall.
- A co-finance model where villagers and the implementing NGO shared the cost for the installment has proven to be a good approach that guaranteed local ownership of the Pond Sand Filter whilst at the same time sharing the financial burden so that the community did not have to cover for it entirely.

*Deatil case studies can be found in Annex-5

Drought tolerant rice trial, Saroil, Godagari, Rajshahi

5 CONCLUSION

It is observed that different adaptation technologies related to agriculture and water has been developed and introduced by different actors in Bangladesh, but all these have not been widely adopted and being practiced by the communities. It has been noted by the IPCC that poor planning, alongside failure to consider long-term outcomes, potential climatic change and adaptation limits can result in maladaptation or, “an adaptation that does not succeed in reducing vulnerability but increases it instead” (IPCC, 2001: 378). In order to avoid such bias when it comes to the implementation of climate change adaptation technologies the lessons learned in implementation practice need to be considered.

In its TEC Briefs on adaptation technology in the agriculture and in the water sector the Technology Executive Committee (TEC) of the UNFCCC has identified several important lessons learned from international projects on adaptation technology (TEC 2014, TEC 2014a).

Regarding Agriculture, the TEC finds that there is a need to manage agricultural resources with an understanding of ecosystems and the human communities that are part of those ecosystems. It has advocated for bottom-up and participatory approaches to enable the replication of local innovations, ensuring sustainability and suitability to local contexts (TEC 2014).

Water is particularly a complex sector because of the intrinsic linkage between freshwater resources and other sectors and ecosystems (UNFCCC, 2012). It is therefore important to be aware that there is no guarantee that a technology that works well in one country will deliver the expected results in a different country. For example, dam and water diversions in one location can have an impact on the water balance and micro-climate in a different part of an ecosystem (Technology Executive Committee 2014a: 2). Therefore, the regional and local conditions need to be critically analyzed and understood well before the implementation of a water technology.

The TEC identified that comprehensive knowledge management is critical to the development, transfer and diffusion of technologies in water sector for adaptation.It further emphasized cost and time efficiency of technologies, citizen engagement with new technology through appropriate marketing and consider anticipated benefits of water technologies in accordance with the specific location of its application (TEC 2014a).

In developing and implementing adaptation technologies a range of stakeholders are involved, including research, private sector, financial institutions, NGOs and communities. Models of their collaboration can significantly impact adaptation technology development and implementations towards better outcomes.

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Annex -1. Adaptation Technology Sub-Group Action Plan for 2017

SL	Organization	Proposed Activities
1	Christian Commission for Development in Bangladesh (CCDB)	Study to assess local adaptation needs and stocktaking of adaptation practices, and Publication of the report
2	Christian Aid Bangladesh	Integration of new innovative/ adaptive technology in programme (Crop & Livestock)
		Dissemination of Agricultural Information through mobile phone
3	Practical Action	Conduct research to assess the climate change adaptation technology needs and success. Also to find out the possibilities of replication and introduce new technologies. Produce knowledge and make sure the wider dissemination to the development agencies and policy makers in the government bodies.
4	ICCCAD	To arrange short courses around every year based on thematic adaptation technologies like Agriculture, Water, Fisheries, etc. Also to publish policy brief, article, collaborative research and publications.
5	BCAS	Focusing more research on identifying innovative and sustainable adaptation technologies in different ecosystems of Bangladesh, integrating scientific and indigenous knowledge with the existing adaptation technologies and wider dissemination to the development agencies and policy makers

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Annex - 3. Adaptation Technology Sub-group Activities in Pictures

The panel of the session on Adaptation Technology in the Gobeshona Conference-3, 2017

Professor Dr. Myles R Allen, Oxford University in the audience of the session on Adaptation Technology in the Gobeshona Conference-3, 2017.

Adaptation Technology Sub-group meeting in CCDB.

Annex - 4. Case Studies on Adaptation Technologies in Agriculture Sector

Participatory Research and Ownership with Technology Information and Change (PROTIC) by Oxfam in Bangladesh

Providing meteorological information to women in marginalized rural communities with Information and Communication Technology (ICT)

Project name and organization:	Participatory Research and Ownership with Technology, Information and Change (PROTIC), Oxfam in Bangladesh
Addressed Problem:	Information gap, gender inequality
Technology description:	200 female farmers from the two areas (100 from each area) have been equipped with smart mobile phone along with internet scheme. Through these mobile phones they receive SMS, Outbound Dial (OBD), Interactive Voice Response (IVR), Apps and Call Centre services on agriculture, agro meteorology and an early warning system.
Location of project:	Borokupot village under Atuliya union at Shyamnagar Upazilla in Satkhira (coast), Dakshin Kharibari village under Tepa Kharibari union at Dimla Upazilla in Nilphamari (charland).
Duration of project :	2015- 2019

Implementation partners, funding partner:

Bangladesh Institute of ICT for Development (BIID), Research Initiatives Bangladesh (RIB), University of Dhaka, Khulna University, Bangabandhu Sheikh Mujibur Rahman Agricultural University and Hajee Mohammad Danesh Science and Technology University (academic partners); Pollisree, Shushilan (local NGOs), WIN MIAKI (telecommunication company), Monash University, Australia (funding).

Methods used for evaluation and monitoring

Comparison with nearby control villages Henchi and Uttar Kharibari. Aside from protecting and improving agricultural production, the research project linked the community with the Union Digital Centre (UDC) and Local Government officials. Communities now actively seek advice from the concerned Agriculture Officer, Livestock Officers, Fisheries Officers. They also participate in projects and meetings in TepaKharibari Union Parishad office and Atuliya Union Parishad office.

Furthermore, the trainings for the use of mobile empowered community members to use it for multiple purposes, such as filling up online forms, accessing news and downloading useful apps. They are also using the mobile phone to take photos of sick poultries and take them to the vet who identified the disease and the cure.

Project Description:

The project aimed to enhance the economic situation of poor and marginalized climate change vulnerable community by providing trust-worthy, relevant and well-timed information on weather conditions and smart agricultural practices in crop farming, homestead gardening, fisheries, livestock, horticulture and poultry. Specifically addressing women, the project increased women's participation, helped to strengthen their leadership role and enhanced their economic situation.

Multiple partners collaborated in the project. The partnering universities carried out demand-based research on agriculture and resilience and generated the data that was disseminated with the ICT. The collaborating telecommunication company WIN MIAKI creates a knowledge hub and provided the data via its Community Information and Advice Service. The local NGOs reached out to the communities.

In the first stage, the partnering local NGOs reached out to the communities and identified community-based organizations (CBO) to partner with, using a purposeful sampling method followed by some criteria. Following this, trainings were held that provided the project participants with skills on the use of the smartphone and agricultural practices, e.g. how to create a fertilizer. Each CBO was provided with a smartphone and a monthly data package which enabled them to receive the information.

Personal Case Study:

The project has also contributed to women's economic empowerment. One example is the case of Provati Rani, a female farmer from Borokupot village. She grows vegetables in her homestead garden using the Vermicompost technique she learned in the project. She also sells the compost to other villagers using her mobile phone. In the project she learned how to receive information via SMS, call center services and apps on agriculture provided by the local department of agriculture office. Due to accessing and using this information she has doubled her productivity. She sells 15-20 kg of worth tk. 20 compost fertilizers per month to the market and has sold 25 kg vegetables. This has increased her income. Provati also uses the phone to communicate with her husband. In her community, Provati has become a role model and she uses face book to disseminate her learning and experience among the other community members.

Key learnings:

- The use of Information and Communication Technology (ICT) is a viable approach to ensure and improve agricultural production under climate stress and to create economic resilience;
- The ICT skills trainings empowered participants by providing transferable skills;
- The cross-cutting collaboration with private sector, universities and local NGO partners contributed to the success of the project;
- The Participatory Action Research approach and the close involvement of the community during the project ensured that the technologies were used.

Pumpkins against Poverty by Practical Action Bangladesh

Project Name:
- Pumpkins against Poverty (UKaid)
- Securing Water for Food (USAID, the Govt. of NL SIDA and Science and Technology, South Africa)

Organisation Name
Practical Action Bangladesh

Addressed Problem:
Food insecurity, climate change, river erosion extreme poverty

Technology Description:
After each rainy season, substantial sandy islands (transitional sandbars) show up in the fundamental streams of the Teesta and Bhramaputra rivers. These islands are the common property as barren resources, and are not utilised for any gainful or productive purposes. The sandbar cropping technology effectively exhibited that growing pumpkins in small compost-pits is both possible and productive. In the sandy island, pits comprising a size of 1m3 are dug. Then compost is inserted inside the pit and then the seeds are sown. After that, regular nurturing and irrigation is done by the farmers until the final harvest comes. Other than the pumpkin, some other crops like squash, cabbage, lettuce, parsley, capsicum, strawberry, melon, onion, flowers like marigold, gladiolus, dalia is being harvested on trial basis. Among these crops, squash is being harvested alongside pumpkins on commercial basis.

Location of the Project:
Rangpur and Kurigram

Duration of the Project:
March 2016 to September 2018

Partners:	Implementation Partner:	Uttara Development Program Society (UDPS)
	Strategic Partner:	Department of Agricultural Extension (DAE)
	Funding Partner:	Department for International Development (DFID)

Methods used for evaluation and monitoring:

- Wealth Ranking for HHs selection
- Baseline survey (100%)
- Training inventory
- Asset inventory
- Routine monthly and quarterly review for quick
- management decision i.e. Evaluation of monthly progress
- Plan VS Achievement
- Quarterly and Annual impact review (Organisational PME)
- Case studies
- HHs record keeping for production data analysis (100%)
- Effectiveness studies at the end of each year(Sample)
- Need based studies i.e. Gender review, environmental
- assessment, final evaluation
- GPS mapping and identify sandbar location and tracking
- the record for future evaluation and review
- Reporting (monthly, quarterly, six months and annual)
- Field visit and findings sharing
- Annual M&E plan and internal M&E framework
- Quarterly outcome tracking output to purpose level.
- Photographs collection and sharing
- Even diary

Results of the evaluation:

A total 2100 (90% female) beneficiaries have cultivated pumpkins in unused barren land in 100 pits. On average 22 decimals land cultivated. The growth rates of all spots are found excellent. The production is estimated and assumed per beneficiary will get on average 3000 kg- 3200 kg per beneficiary (3.2 MT from 0.1 ha sandbar from 170 days) and it will be sold Tk. 8-10 taka per kg. During monsoon the cost jumps to 20-25 Tk per Kg. Other than that, 2100 beneficiaries cultivated squash and every beneficiary got on average production 450 kg. The beneficiary sold the production Tk.10 per kg and some consumed.

Project description:

The project is working in 26 villages of 11 unions and they are Chilmar, Ramna, Thanahat, Ranigonj, Kurigramsadar, Holokhana, Mogalbasa, Jatrapur, Gogadoha, Alambiditor, Nohali under the 3 upazila of Chilmari, Kurgram Sadar and Gangachora of Rangpur and Kurigram district. The number of beneficiaries (with breakdown of female/male/others/HHs): 6000(Female-60%, Male-40%)

The Project has selected most vulnerable embankment extreme poor people through wealth ranking process/community lead approach. It is supporting them to ensure operational access through negotiation with District Administrators, Local Government and Sub-District Administrators and local leaders. Also advocating to influence the Government offices to establish formal operational access to the sandbars for five-six months a year. The project will follow a pumpkin plus approach by including livestock farming, to provide sustainable incomes through the seasons for this very vulnerable group. This work will include facilitating access to markets. Livestock are an important component of the project because, not only do they add diversity to income strategies and diet but they also contribute vital manure fertilizer to the pumpkin pits, without which significant additional investment would be needed.

The project will facilitate nutritional supplementation and awareness raising work about the importance of adequate and equitable nutrition because malnutrition is a huge issue amongst extremely poor women. We will promote community based extension system for long term sustainability of the project activities. Group meeting, counseling, individual contact, training, orientation, group discussion, meeting workshop, field visit, social mobilization, market linkage, learning visit etc. methods are used to interact beneficiaries, community and different stakeholders to achieve the project targets objectives.

Key learnings:

- Pumpkin cultivation, high value crop squash, watermelon, lettuce, beetroot, cabbage, commercial flower cultivation, onion, garlic can be referred in wider scale with joint collaboration with local govt and land owners;

- The innovation has brought huge opportunity to bring barren lands under bulk amount of food production by the landless living on the edge of mighty rivers and close to sandbar. The innovation is not helping food security, but offering a basket full of solutions to the big global causes like hunger, nutrition, employment, gender inclusion, women participation in agriculture, economic graduation etc. Additionally, showing a strategic directions and a path for future agriculture in balancing population growth and arable land losses in coming decades to feed 200m people by 2050;

- Moreover, the innovation is offering a wide range of varieties i.e. pumpkin, high value crop squash, water melon, lettuce, bit root, cabbage, onion, garlic and commercial basis flower production again to spare fertile lands for major cereals in recent cropping system in Bangladesh;

- The women have participated actively without hampering any household's works and male adult members can earn as a labour beside these works. Food security, family nutrition, lean season management, income increase and asset generation are improving for this cultivation. There are a vital opportunity the whole family members are practicing this sandbar cropping technology and resulting the sustainability of the technology is increasing day by day. The underutilized sandbar barren land is cultivating by this technology and the technology is contributing productivity in household level as well as national level. The land is becoming fertile and people is adapting the climate change and especially the women are becoming technically sound about this technology;

- Finally, it has already created huge employment and in particular for women not only for their food security, but turned them as agriculture entrepreneurs.

Annex - 5. Case Studies on Adaptation Technologies in Water Sector

Pond Sand Filter for Resilience

Project Name:

Ensuring Food Security and Saline Resilient Livelihood through Community Based Adaptation Satkhira Unnayan Sangstha (SUS)

Addressed Problem: Lack of clean water and health issues as result of bad drinking water

Technology Description: Pond Sand Filter (PSF) has been used in the coastal areas of Bangladesh since a while. The technology is built around artificially constructed ponds, locally known as "sweet water ponds" which are replenished by rainwater during the monsoon season. The rainwater collected in these ponds is pumped by hand into a storage tank through a filter chamber. The filter chamber is constructed in two parts, the first of which is a pre-filter packed with coconut fibers. This pre-filter reduces the turbidity of the raw water as the raw water flows into the filter chamber. The outflow from the pre-filter flows into the main body of the filter chamber through two overflow pipes. The main filter chamber consists of a layered, sand filter bed, through which the water trickles and in which impurities, including bacteria, are removed in a manner similar to slow sand filtration. The quality of the raw water is further protected through the reservation of the ponds feeding into the filtration system solely for potable water use (UNEP).

Location of project: Patchbaria village of 9 no. Mothureshpur union of Kaliganjupazila in Satkhira district

Funding partner: The project was part of Community Climate Change Project (CCCP) funded by PKSF.

Maintenance of technology:

Routine cleaning of the PSF is required. The rate of filtration gradually decreases over time, with the length of run resulting in increasing head loss. In order to maintain a constant rate of filtration, the height of water above the sand bed can be increased; however, a time will come when the filter bed must be cleaned to restore a reasonable rate of filtration. When the turbidity of the pond water is less than 8 NTU, the usual time between cleanings is about five months. When the turbidity increases to 30 NTU, it may be necessary to clean the filter every one and half months. The length of run also depends on the number of users drawing water from the system. Cleaning of the PSF is very simple and can be accomplished by two persons in under 45 minutes (UNEP).

Applicability in Bangladesh:

This technology is suitable for use in areas where there is adequate (seasonal) rainfall. In Bangladesh, the use of this technology is limited to those areas lacking access to adequate groundwater sources which can be accessed using tubewells are found to be successful in the location. In the areas where PSF system developed, tubewells are not successful as suitable fresh water aquifers are not available at reasonable depth. Groundwater is saline down to depths of 200 m to 350 m, and naturally occurring surface water sources are saline and also polluted. Average life of a PSF is a minimum of 10 years. The use of PSF has the potential to revolutionize the drinking water systems in saline areas of southern Bangladesh, covering the Greater Khulna, Patuakhali, Barisal and Noakhali districts (UNEP).

Results:

The community has now access to clean drinking water and the health of community members has improved.

Project Description:

Water is scare for drinking and cooking in Patchbaria village of 9 no Mothureshpur union of Kaliganjupazila in Satkhira district. People of this village used to drink pond water without purification. As a result, they suffer from different diseases. To improve the situation, a sand pond filter was installed. SUS had several community level consultations with the villagers. The NGO proposed the villagers to find a suitable pond for establishment of a Pond Sand Filter for supply of water.

Provas Mondol a retired teacher in Patchbaria and a village elder was proposed by SUS and other villagers to contribute his pond for establishment of PSF. Provas Mondol was convinced and agreed to give his pond for the purpose. The pond has an area of 15 decimals. SUS mobilized the community to form a community group. An executive committee was formed with 11 members for management of the group and PSF. The group has over 200 active member households. The pond was re-excavated during April 2014 and PSF was installed and operational since April 2015. A total of 80000 Taka was spent for re-excavation of the pond and PSF construction cost was 16000 Taka. The villagers contributed 16000 Taka as community contribution, rest of the amount was provided by SUS. All the households of the village have contributed more or less in cash to accumulate community contribution required. Members household are contributing through monthly subscription for cleaning and maintenance of the PSF. The Executive committee is maintaining a bank account with First Security Islamic Bank, Kaliganj branch. Realizing the community benefit the Union Parishad has constructed connecting road, so that people can collect water easily from the PSF.

Key learnings:

- The PSF provides a viable solution to scarcity of drinking water in areas of Bangladesh with adequate seasonal rainfall.
- A co-finance model where villagers and the implementing NGO shared the cost for the installment has proven to be a good approach that guaranteed local ownership of the Sand Pond Filter whilst at the same time sharing the financial burden so that the community did not have to cover for it entirely.

Pond sand filter (PSF), Atulia, Satkhira

Annex - 6 -Technologies in the Agriculture Sector in Bangladesh

Categories	Name of the technology Initiative	Needs Addressed	Function	Adaptation Effects	Implemented area	Name of the implementing organization
Capacity Building and Stakeholder Organization	Farmer Field Schools / Climate Field School	Building of formal and informal institutions and social networks. Information for decision making. Heightened awareness of and access to climate change information.	The Farmer Field School (FFS) is an early innovative model for community based farmer education based on non-formal, adult educational or "discovery learning" methods, developed some 20 years ago in response to the weaknesses of more "top-down" extension models of the time. Presently Farmers Field Schools are being converted as Climate Field School by the Department of Agricultural Extension.	Builds farmer capacity to respond to climatic impacts. Trains farmers in participatory methods and technical aspects of integrated pest management and other responses. Farmer networking and capacity for collective actions can gain FFS members access to governance and policy processes and achieve their empowerment	52 Upazilas under 26 districts of Bangladesh Char lands of Dinajpur, Rangpur, Kurigam,	Department of Agricultural Extension (DAE), under the Ministry of Agriculture. Oxfam and Partner NGOs
Crop Improvement	Biotechnology	Food security, Stabilized and/or increased productivity, Crop improvement/optimization of crop structure	Genetically modifying crops in order to increase their resistance to climatic effects such as drought, pests and other stressors. Genes from tolerant crop types are utilized – particularly from wild crops often found to be resilient to salinity and heat stress.	Increases the resilience of crops by targeting the specific stressor they are exposed to and genetically modifying the crop to tolerate such stressors. Increases food security by enhancing production through increased and more reliable yields. Reduces water stress due to reduced need for fresh water supply. Could enable less fertile and marginal land to be farmed.	Sirajganj, Rangpur, Kurigram, Gaibandha and Lalmonirhat districts of Northern region, Satkhira, Khulna and Bagerhat districts of south-west coastal region in Boro season.	BRRI, BARI, BINA,BLRI, BJRI, BRRI and IRRI Under CSISA project/USAID funding

Categories	Name of the technology Initiative	Needs Addressed	Function	Adaptation Effects	Implemented area	Name of the implementing organization
Hydroponic agriculture practices	Floating Agriculture	Agricultural sustainability in flood prone /water logged areas, crop production, food security	Floating vegetable beds grown in water logged and salinity prone areas. Traditional practice strengthened by scientific and technological input to create longer and stronger beds, and enable crop rotation and cultivation of diversified vegetables and. Floating gardens or baira are bases created by planting aquatic crops such as water hyacinths on soilless rafts on water and used for raising seedlings, vegetables and crops, which get nutrition and food either from composted organics or from the water.	Increase employment and income rates. Provide food and nutrition for families and communities. Allow earlier cultivation of seedlings for a better harvest. Provide organic compost for dry season cultivation.	Gopalganj, Madaripur, Barisal, Pirojpur and Jhalokathi Districts, Gaibandha District Different districts of Bangladesh including Haor areas.	Farmers/ CARE and Practical Action, GonoUnnayanKendro Department of Agricultural Extension (DAE)
Soil Management	Bio Digester	Sustainable agricultural practices	Utilizes livestock waste to produce bio-gas that can be used for cooking and other energy needs and organic fertilizer for increased agricultural production. Models include fixed dome models, developed in China, and floating drum models, developed in India. Fixed dome digesters are filled through an inlet pipe, which is positioned so that slurry falls into the bottom layer while biogas accumulates in the top part of the dome chamber. Gas pressure is created due to differentiated levels of accumulation between the slurry level and the expansion chamber. This pressure causes the slurry to move into the expansion chamber and once the gas is released via an outlet pipe and tap, the slurry flows back into the digester. Floating drum digesters involve a movable inverted drum, which acts as a storage tank and is placed on a well-shaped digester that is able to move up and down depending on the volume of gas accumulated. The weight of the drum pressurizes the gas, allowing it to move through the outlet pipe and be released via a tap. The remaining slurry can be used as a fertilizer	Provides a sustainable source of organic fertilizer for increased crop yields and heightened food security – the fertilizer is rich in nutrients including nitrogen, phosphorus, and potassium. Promotes sanitation. Improved health impacts due to limited use of chemical fertilizer. Enhances economic resilience by reducing costs of fuel and fertilizer and enabling enhanced income due to the high commercial value of the fertilizer produced and the related job opportunities available. Reduces deforestation, soil erosion and loss of cultivable land by providing an alternative fuel source. Reduces cooking times, thereby allowing more time for alternative livelihood activities	Savar, Gazipur, Dinajpur, Rangpur, Gaibandha, Pabna District	Grameen Shakti, IDCOL supported with SNV and KFW,BCSIR, LGED,BBDF, BAU

Categories	Name of the technology Initiative	Needs Addressed	Function	Adaptation Effects	Implemented area	Name of the implementing organization
Sustainable Crop Management	Crop Diversification	Stabilized and/or increased productivity. Food security	A shift from traditionally grown less remunerative crops to more remunerative crops that are more resilient and stable in production	Food and nutritional security and poverty alleviation. Natural resource management for sustainable agricultural development.	Satkhira and Patuakhali, Khulna, Bagerhat and Pirojpur districts, Drought prone regions/Barind tract, Rajshahi, Chapainawabganj, Natore, Naogaon districts	CCDB, BRAC, AAS with funding support from STRASA (a project of IRRI funded by BMGF).
	Crop Substitution	Risk reduction Increased agricultural productivity	Substituting crop varieties to those more suitable for altered climatic conditions.	Reduces the risk of complete crop failure due to drought or untimely heavy rainfall. Avoids loss of crops due to variations in climate. Can take advantage of the early production of crops by growing further additional crops once original crop has been harvested.	Nashipur and Rajshahi. Noakhali and Shatkhira coastal zone, Teesta River in Lalmonirhat district and chars of the Ganges River in Rajshai district and chars of Chapainawabganj districts	FAO, AAS,BARI, BRRI
	Cattle rearing	Risk reduction	In the haor areas of Kishorgonj most of the farmers cultivating Boro rice are from outside districts. They use to make temporary residence in the crop fields during Boro season. These farmers bring cattle for rearing in the Haor areas where plenty of green fodder available. The cattle grow healthier and farmers can sale those with higher prices	This is a traditional practice of risk reduction in haor areas due to crop loss by flash flood. In case of crop loss livestock provides support to the farmers	Kishorgonj	Traditional practice

Categories	Name of the technology Initiative	Needs Addressed	Function	Adaptation Effects	Implemented area	Name of the implementing organization
Urban Agriculture	Roof Top Gardening	Food security. Stabilized and/or increased productivity	Growing of crops in plants and beds on roof tops to provide an alternative source of food for household and community use.	Improves food security by increasing food production options. Particularly important resource when crops on the ground are inundated by flooding Particularly beneficial in urban areas, where space is limited.Can improve economic resilience through providing an alternative source of income	Dhaka	Both Dhaka North City Corporation DNCC and Dhaka South City Corporation (DSCC) Green Savers

Annex - 7. Technologies in the Water Sector in Bangladesh

Categories	Technology	Addressed Needs	How the Technology Works	Adaptation Effects	Location	Implementing Organization
	Desalination	Supply of clean water	Purifying plant uses reverse osmosis process	Resilience to water quality degradation. Provides a source of pure water for drinking and other domestic and large scale use.	Satkhira	Nowabenki Gonomukhi Foundation (NGF)
Improving water quality	Pond Sand Filter	Pond Sand Filters (PSFs) are used to clean contaminated bodies of water, particularly surface waters of freshwater ponds that collect rainwater.	Contaminated water passes through a pre-treatment chamber of gravel and a filter made from sand to block the sand and other solids within the water and remove pathogens. For smaller grains, chemical and biological processes can be used alongside this physical process to aid the filtration of the water.	Resilience to water quality degradation. Provides a source of pure water for drinking and other domestic and large scale use. Increases water security. Increase economic development and therefore heightens economic resilience.	Satkhira, Bagerhat, Khulna, Barguna	SatkhiraUnnayanSangstha (SUS), DakDiye Jai, Jagrata Juba, Shangha (JJS), NowabenkiGonomuki Foundation (NGF), SangathitaGramunnanKarmasuci (Sangram), UnnayanProchesta, Prodipon, Islamic Relief World Wide Bangladesh, Nobolok, Water Aid

Categories	Technology	Addressed Needs	How the Technology Works	Adaptation Effects	Location	Implementing Organization
Improving water quality	Solar Disinfection	Supply of safe drinking water for domestic use	Solar water disinfection is a type of portable water purification that uses solar energy to make biologically-contaminated (e.g. bacteria, viruses, protozoa and worms) water safe to drink. Water contaminated with non-biological agents such as toxic chemicals or heavy metals require additional steps to make the water safe to drink. Solar disinfection involves the removal of bacteria, protozoa and other viruses from water. Bacteria and virus are removed when water is kept above 62.8°C for 30 minutes or above 71.7°C for 15 seconds. Water is put in PET bottles or other transparent water containers and left in a place highly exposed to sunlight for 6 hours.	Diversity of safe water supply when alternative sources become unusable – less time spent on water collection enables more time to be allocated to agriculture and other livelihood activities. Increases water security.	Rajshahi Bagerhat	CARE Bangladesh
Rainwater Harvesting	Rooftop Harvesting	Supply of fresh water for domestic use Conservation of water resources Traditional methods of water management	Collection and storage of rainwater for domestic and agricultural use. Systems can be installed at individual, household and community scale.	Increases water security. Provides a source of freshwater for agricultural use and consumption. Provides a source of water in periods of drought.	Satkhira, Patuakhali Khulna, Bagerhat, Naogaon	Christian Commission for Development in Bangladesh (CCDB), SatkhiraUnnayan Sangstha (SUS), NGO Forum for Public Health, UnnayanSangstha,DhakaAhsania Mission,Prodipon,IslamicRelief, WorldWide,Bangladesh, Nobolok, Water Aid

Categories	Name of the technology Initiative	Function	Adaptation Effects	Needs Addressed	Implemented area	Name of the implementing organization
Rainwater Harvesting	Artificial Aquifer	Supply of fresh water for domestic use Conservation of water resources Traditional methods of water management	Collection and storage of rainwater for domestic and agricultural use. Systems can be installed at individual, household and community scale	Increases water security. Provides a source of freshwater for agricultural use and consumption. Provides a source of water in periods of drought.	Satkhira, Patuakhali Khulna Bagerhat Naogaon	Christian Commission for Development in Bangladesh (CCDB), SatkhiraUnnayanSangstha (SUS), NGO Forum for Public Health, UnnayanSangstha,DhakaAhsaniaMission,Prodipon,IslamicRelief,World Wide,Bangladesh, Nobolok, Water Aid
Groundwater extraction	Artificial AquiferTube Well	Supply of fresh water for domestic use	Groundwater extraction through the use of individual scale domestic wells. Covers can be applied to make wells flood resilient.	Enhance economic resilience, significantly improving agricultural economies.	Pirojpur	Practical action
	Deep Tube well	Supply of fresh water for domestic use	Groundwater extraction from deep aquifer. Deep tubewells are used to supply water to a relatively larger group of people and are common in urban areas. Some parts of the coastal region of Bangladesh are very suitable for construction of deep tubewell.	Supply of safe drinking water. Improved water security. Provide a source of water for large scale use in the domestic and agricultural sector.	Barguna, Patuakhali, Bagerhat, Khulna, Barisal, Satkhira	NazrulSmritiSangsad -NSS, Association for Realization of Basic Needs (ARBAN), SangathitaGramunnaonKarmasuchi (Sangram), Shaplaful, UDDIPAN

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